Synopsis of Proposed Research Work

Entitled

Fuzzy Linear Programming Approach for Solving Industrial Problems

Submitted

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Abstract of proposed work plan

"Fuzzy Linear Programming Approach for Solving Industrial Problems"

1. Introduction :

Linear Programming is one of the most frequently applied operation research techniques. Although it has been investigated and expanded for more than six decades by many researchers and from various points of view, "It can be viewed as part of a great revolutionary development which has given mankind the ability to state general goals and to lay out a path of detailed decisions to take in order to 'best' achieve its goals when faced with practical situations of great complexity. Tools for doing this are ways to formulate real-world problems in detailed mathematical terms (models), techniques for solving the models (algorithms), and engines for executing the steps of algorithms (computers and software)."

In the years from the time when it was first proposed in 1947 by Dantzig, linear programming and its many forms have come into wide use worldwide. LP has become popular in academic circles, for decision scientists (operations researchers and management scientists), as well as numerical analysts, mathematicians, and economists who have written hundreds of books and many more papers on the subject. Though it is so common now, it was unknown to the public prior to 1947. Actually, several researchers developed the idea in the past. Fourier in 1823 and the well-known Belgian mathematician de la Vallée Poussin in 1911 each wrote a paper describing today's linear programming methods, but it never made its way into mainstream use. A paper by Hitchcock in 1941 on a transportation problem was also overlooked until the late 1940s and early 1950s. It seems the reason linear programming failed to catch on in the past was lack of interest in optimizing.

Classical optimization techniques and methods have been applied successfully for solving optimization problems when the decision parameters are crisp. In crisp linear programming problems, sharp constraints are combined to limit the space of feasible solutions. The linearity of the constraints and the objectives enables straight forward solution methods. There are various ways to visualize how the LPP method achieves an optimal solution for a linear system. Therefore LPP in the crisp scenario aims at maximizing or minimizing a linear function under linear constraints.

But many real life problems have flexible, approximate or uncertain constraints and goals for improving the optimization objective value. Hence, the decision maker may not be in a position to specify the objective or constraint functions precisely. The impreciseness may be due to the measurement inaccuracy, insufficient information, simplification of physical models, variations of the parameters of the system, computational errors etc. In such situations, to improve the decision maker's aspiration level and to deal with flexible goals and constraints, fuzzy set theory is desirable to use as it captures the uncertainty in the model very well.

Fuzzy linear programming problem is a refinement of crisp LPP which was developed since 1970's. The fuzzy objective function is characterized by its membership function, and so are the constraints. When decision is to be made in an fuzzy environment many possible modifications of the classical LPP model exists, such as,

1. The decision maker might not really want to maximize or minimize the objective unction rather he might want to achieve some aspiration level which might not be even definable crisply. For example, the decision maker might want to improve present profit considerably.

2. Constraints might be vague "≤" sign might not be meant in the strict mathematical sense but subjectively determined violations may be acceptable. For example, the decision maker might say try to contact 1300 customers but it will be too bad if less than 1200 customers are contacted.
3. The entries of vectors may not be crisp but rather may be fuzzy numbers and the inequalities may be interpreted in terms of ranking of fuzzy number.

2. Review of Literature and Development in the subject :

- **In 1965 ,** Fuzzy set theory was developed by Zadeh A. Lotfi
- **In 1970,** The concept of fuzzy decision and the decision model under fuzzy environments were anticipated by Bellman and Zadeh.
- **In 1978,** Zimmerman proposed the first formulation of fuzzy linear programming.
- **In 1983,** Chanas anticipated the possibility of the recognition of a complete fuzzy decision in fuzzy linear programming to make use of parametric programming technique.
- **In 1987,** Werners introduced an interactive system which supports the decision maker in solving programming models through crisp or fuzzy constraints and crisp / fuzzy goals.
- **In 1997**, Cadenas and Verdegay studied a linear programming problem in which all of its elements are defined as fuzzy numbers.
- **In 2000**, Buckley and Feuring introduced a method to find the solution for fully fuzzified linear programming problems with all the parameters and variables as fuzzy numbers by changing the objective function keen on a multi-objective fuzzy linear programming problem.
- **In 2001,** Liu proposed a method for solving fuzzy linear programming

problems based on the satisfaction degree of the constraints.

- **In 2003,** Zhang et al. proposed a method for solving fuzzy linear programming problems which involve fuzzy numbers in coefficients of objective functions.
- **In 2004,** Nehi et al. (2004) defined the concept of optimality for linear programming problems with fuzzy parameters by transforming fuzzy linear programming problems into multi-objective linear programming problems.
- **In 2006,** Ganesan and Veeramani proposed an approach to solve a fuzzy linear programming problem involving symmetric trapezoidal fuzzy numbers without converting it into crisp linear programming problem. And Hashemi proposed a two-phase approach to find the optimal solutions of class of fuzzy linear programming problems, where all decision parameters and variables are fuzzy numbers.
- **In 2007,** Jebaraj and Iniyan (2007) developed a fuzzy-based linear programming optimal energy model that minimises the cost and determines the optimum allocation of different energy sources for the centralised and decentralised power generation in India.

  Rommelfanger proposed a new method for solving stochastic linear programming problems with fuzzy parameters. Allahviranloo et al. solved the fuzzy integer linear programming problem by reducing it into a crisp integer linear programming problem.

  Jimenez et al. proposed a method for solving linear programming problems where all the coefficients are fuzzy numbers and used a fuzzy ranking method to rank the fuzzy objective values and to deal with the inequality relation on constraints.
- **In 2009,** Lotfi et al. (2009) proposed a method for solving FFLP problem using lexicography method and provided fuzzy approximate

solution.

Rommelfanger proposed a new method for solving stochastic linear programming problems with fuzzy parameters.

Allahviranloo et al. solved the fuzzy integer linear programming problem by reducing it into a crisp integer linear programming problem.

Jimenez et al. proposed a method for solving linear programming problems where all the coefficients are fuzzy numbers and used a fuzzy ranking method to rank the fuzzy objective values and to deal with the inequality relation on constraints.

3. Objectives of Research/ Proposed Hypothesis:

i) To find the linear programming problems to apply the fuzzy concepts, fuzzy numbers and analyze the following points.

- To study some of the membership functions [Triangular MFs, Trapezoidal MFs, Gaussian MFs, Generalized bell MFs, Sigmoid MFs, Left-right MF (L-R MF)].
- To study the different types of fuzzy numbers (Triangular fuzzy number, trapezoidal fuzzy number, bell shape fuzzy number, pentagonal fuzzy numbers, hexagonal fuzzy numbers, etc).
- Try to explore some properties of Linear programming problems and optimization problems.
- Investigate the real life problems and try to find their solutions.

ii) Using scientific tools , try to work on following points

- Apply the crisp transportation function to fuzzy linear programming problems.
- To find the different types of generators and fuzzy numbers.
- To find the linear programming problems and their solutions by using MATLAB/SCILAB/Python/SAGE or any other scientific tool.
- Try to apply the Linear programming problem analysis to the different

areas or fields.

4. Methodology to be adopted:

- Collecting the data/research papers by using primary sources, internet and reference books.
- Establishing the validity and reliability of a research data.
- Study the membership functions, fuzzy numbers, crisp functions.
- Analyze the linear programming problems.
- Selection of methods of determining the qualitative research work.
- Obtain the optimal solutions of fuzzy linear programming problems by using different methods.
- Obtain the optimal solutions of linear programming problems by using different scientific tools.

5. Importance of study/ Society application:

i) International Status :

- **In 2008 S.H.Nasseri** has been proposed a new method for solving the classical linear programming problems where we know how to solve them. Also providing a new method for solving the fuzzy linear programming problems without using any ranking function.
- **In 2014, Shapla Shirin and Kamrunnahar** discussed the fuzzy optimization problem has been modeled by considering different fuzzy linear programming problems.
- **In 2015, Se-Ho Oh, Myungho Lee and Wooyoung Song** has developed a method to solve the fuzzy linear programming problem with equality constraints. The solution based on the max-min rule is obtained by solving the crisp linear programming problem derived from the immermann's symmetric model. In the over-estimated system, a family of approximated solution with acceptable degree are often more meaningful than the unique

least square solution.

- **In 2016, A. Hosseinzadeh and S.A. Edalatpanah** has proposed a method of solving the fully fuzzy programming problem with fuzzy numbers. Also they have proved that the FFLP problem is converted into an MOLP problem using fuzzy calculus and solved by lexicography method and linear programming methods. The proposed scheme presented promising results from the aspects of computing efficiency and performance.

ii) National Status :

- **In 2012, C.Veeramani C.Duraisamy** has Solved Fuzzy linear programming problem using symmetric fuzzy numbers approximation.
- **In 2012, Chinnadurai Veermani** has proposed a new method for solving the FFLP problems. Here, all the parameters and variables are triangular fuzzy numbers. The concept of NSTFNA is used and the FFLP problem is reduced to two linear programming problems. And also fuzzy approximate solution has been obtained by solving the two linear programming problems.
- **In 2013, Thangaraj Beaula and S.Rajalakshmi**, has proposed a new method to find the fuzzy optimal solution of fully fuzzy linear programming problems using breaking point and duality theory. By using the proposed method the fuzzy optimal solution of fully fuzzy linear programming problem with inequality constraints has been obtained.
- **In 2014, A. Karpagam and Dr.P. Sumathi** , has proposed a computational method for solving fully fuzzy linear programming problems (FFLPP) based upon the new Ranking function. The proposed method is very easy to understand and to apply for fully fuzzy linear programming problems occurring in real life situations as compared to the existing methods.

- **In 2018, C Muralidaran and B Venkateswarlu** has proposed a method having simple steps to compute the fuzzy optimal solution for the symmetric fuzzy assignment problems (Equally spread). These kinds of problems can be solved by proposed method easily without converting them as a crisp. Minimum time for each job is considered for assigning it machine. Fuzzy assignment problems require computing reduced cost matrix.

iii) Significance of the study :

The aim of this study is to revise the theory of fuzzy linear programming, develop linear programming problems and try to solve these by using fuzzy parameters, fuzzy numbers and different scientific tools. Also by using crisp transportation function tries to solve the fuzzy linear programming problems. And analyze the real life problems to find their solutions by using fuzzy concepts.

6. Proposed work Plan/ Formulation and Structure of Study:

Sr.No.	Duration	Plan of work and targets to be achieved
1	First Year	Review of literature (research papers, articles, reference books, etc)
		To study the membership functions, fuzzy numbers, crisp functions and their concepts.
2	Second Year	Try to apply fuzzy numbers, crisp transportation functions to Linear Programming problems.
		Find the solutions of Linear Programming Problems by using fuzzy concepts, fuzzy numbers.
3	Third Year	Try to find the scientific tools, suitable to solve fuzzy LPP and get their optimal solutions.
		Publication of research work.

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